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Minutes of Meeting to Review Disposition of the S-IVB/IU and Related Support Requirements During the Post Injection Phase of Lunar Missions

15 JUL 1964

A meeting was called on July 8, 1964, at NASA Headquarters by Major General S. C. Phillips, Deputy Director Apollo Program, to resolve:

1. The disposition of S-IVB/IU on lunar missions, and
2. The requirements on the instrumentation and tracking subsystems imposed by this disposition.

The meeting was attended by representatives of NASA Headquarters, MSFC, MSC, OTDA, KSC, GSFC, and Bellcomm. Attachment A is a list of attendees. A summary of the proceedings is presented below, which includes the requirements which were defined, a description of the methods of meeting these requirements, a brief description of several problem areas, a list of action items, and a brief summary of the presentations made at the meeting.

Requirements for Disposal of S-IVB/IU

Based on the information presented, General Phillips directed that the following requirements for disposal of the S-IVB/IU during lunar missions be implemented:

1. The S-IVB/IU shall not impact the spacecraft subsequent to the separation of the CSM/LEM and the S-IVB/IU.
2. Although it is desirable to avoid the moon and the earth, no changes shall be introduced on the space vehicle which incur a weight, cost or schedule penalty for this purpose.
3. No special provision for tracking the S-IVB/IU after spacecraft separation shall be provided. The post separation trajectory of the S-IVB/IU shall be determined on the basis of preseparation tracking or post separation telemetry, or both.

Methods of Meeting Disposal Requirements

The procedure described below is considered acceptable for meeting the above requirements.

The space vehicle will be injected on the nominal free return lunar transfer trajectory required for a given mission. After transposition, the CSM/LEM will separate from the S-IVB/IU using the SM

Reaction Control System, leaving the S-IVB/IU trajectory unperturbed. The separation velocity of the spacecraft, on the order of 1 fps, will provide an increasing separation between the spacecraft and the S-IVB/IU. The trajectory of the S-IVB/IU will be known within certain limits so that midcourse correction of the spacecraft trajectory can be programmed to avoid the S-IVB/IU.

If possible, the S-IVB/IU will be reoriented after separation to permit any remaining RCS propulsive capability in the S-IVB to provide an increased separation velocity for a more rapid separation from the spacecraft. This change in the S-IVB/IU trajectory can be determined with S-band telemetered information from the IU. This mode will be omitted or terminated in cases where knowledge of the S-IVB/IU trajectory would be appreciably degraded by performing this maneuver.

Problem Areas

Several problem areas were discussed that require further attention.

After CSM separation at the beginning of transposition, the LEM adapter panels are deployed to expose the LEM. These panels in their retracted position interfere with S-IVB/IU-MSFN communications since they mask the IU antennas. Inter-center panel action has been initiated to seek a solution to this problem.

Monitoring the status of S-IVB/IU systems during the post injection period requires a telemetry capability currently planned to operate at S-band. Verification of the S-IVB/IU trajectory after stage-off will use this same telemetry system. The required antenna pattern characteristics and attitude profiles during these phases are being established.

Mission flexibility will require the capability to control S-IVB/IU attitude from the ground during and for at least ten minutes after transposition and docking. Coverage is limited by the visibility afforded by the number of ground stations currently implemented with launch vehicle command up-data capability.

Action Items

The following were designated as action items on Mr. O. Hoberg for MSFC:

1. Review the UHF up-data requirements for the S-IVB/IU during orbital and post-injection phases to determine if the currently planned implementation is adequate. Particular attention is to be directed to the need for coverage from Ascension and Guam, and to attitude constraints imposed by the use of directional antennas. This is to be completed within one week.

2. If additional up-data coverage capability is required as a result of (1), then a study will be made of the available trade-offs between the additional MSFN implementation required and possible changes in the type of S-IVB/IU up-data system. The present recommendation of the I&CP for implementation of FSK modulation in the MSFN 450 mcs up-data link did not take into account the cost of additional coverage from Guam and Ascension.

3. A study will be undertaken to evaluate the application of the Unified S-band System to the S-IVB/IU. Any application of the USB in the S-IVB/IU must be compatible with the presently planned USB ground system. The S-IVB/IU USB would replace the current planned S-band telemetry link development with an objective of also replacing the 225-260 mcs VHF T/M links and the 450 mcs UHF up-data link after the USB system has been proven. The VHF T/M and UHF 450 mcs up-data link would be retained for Vehicle R&D. It was noted that if USB is a possibility for the S-IVB/IU then the UHF 450 mcs S-IVB/IU up-data link should use PSK modulation which is already implemented in the MSFN. The target date for the operational use of USB would be SA-503. MSFC will advise MA when this study can be completed.

Presentations

Mr. O. Hoberg of MSFC introduced several speakers who discussed the different aspects of the problem.

Mr. L. Jenkins, MSC, described the IU antenna masking problem caused by the folding back of the LEM adapters to expose the LEM for transposition. The four panels are 12 feet long. Collectively, they cover about half of the IU circumference. A study of propulsive disposal of these panels shows a weight penalty of 200 pounds is required to provide a ΔV of 30 fps. Mr. Hoberg indicated that a group was being formed to seek a solution to this adapter problem with joint membership from the following panels: Flight Mechanics, Mechanical Integration, Flight Control Operations, and Instrumentation and Communications.

Mr. J. Winch, MSFC, reviewed the results of a disposal trajectory analysis which described the ΔV and fuel weights required for several disposal modes. These are summarized in Attachment B which is a copy of the view graphs used by Mr. Winch. Briefly, controlled S-IVB/IU disposal to solar orbit or lunar impact using RCS propulsion requires a range of 150 to 2500 pounds of fuel. Disposal through a planned less than nominal S-IVB/IU burn (for lunar impact) required an additional SM propulsion capability to make up for the reduced injection velocity. The S-IVB/IU fuel weight saved does not fully offset the weight of SM fuel required.

Dr. F. A. Speer, MSFC, stated that the S-IVB/IU post-disposal trajectory could be determined from guidance and navigation information

normally telemetered to earth from the S-IVB/IU. Tracking during these phases would be desirable for post-mission analysis, but is not essential for real-time trajectory determination so long as the on-board systems are functioning.

T. A. Barr of MSFC discussed the current implementation planning for S-IVB/IU up-data, telemetry and tracking systems. These plans are described in Attachment C which was prepared by Mr. Barr. The significant points are: an extended range 450 mcs UHF up-data system using a directional antenna (gain = 5db); a PCM-FM S-band telemetry system with a directional antenna (gain = 9db); and a range/range rate tracking transponder. The extended range up-data systems may require an up-data capability at Guam and Ascension which is not presently planned for. It was decided during the discussions that an S-band tracking transponder would not be provided for S-IVB/IU disposal.

Original signed by
J. K. Holcomb

Samuel C. Phillips
Major General, USAF
Deputy Director, Apollo Program

Attachments A, B and C

Copies to:
M
MAT
MAS
MAR
MAP
Director, KSC
Director, MSFC
Director, MSC
Director, GSFC
Director, OTDA
Attendees

ATTENDEES AT JULY 8 MEETING ON S-IVB/IU DISPOSITION

NAME	ORGANIZATION
General S. Phillips	NASA HQ/MA
J. K. Holcomb	NASA HQ/MAO
J. T. McClanahan	NASA HQ/MAO
L. G. Richard	MSFC/R-ASTR
H. Golden	MSFC/R-ASTR-I
O. Hoberg	MSFC/R-ASTR-I
T. A. Barr	MSFC/R-ASTR-IR
H. Palaoro	MSFC/R-P&VE-DIR
J. C. McCulloch	MSFC/I-I/IB-S-IVB
W. P. Varson	GSFC
P. J. Bayer	NASA HQ/MAO
P. E. Reynold	Bellcomm/MAS
P. F. Sennewald	Bellcomm/MAS
J. B. Winch	MSFC/R-AERO-D
R. H. Bruns	KSC/K-ED
V. M. Dauphin	MSC/ISD
D. R. Broome, Jr.	MSC/ASPO
G. M. Truszynski	OTDA
L. M. Robinson	OTDA
H. C. Kyle	MSC/ISD
J. J. Hibbert	Bellcomm
F. Kurtz	MSFC/R-AERO-FO
F. A. Speer	MSFC/R-AERO
C. H. Perrine	MSC/ASPO
L. Jenkins	MSC/ASPO
J. P. Downs	Bellcomm/MAS

ATTACHMENT "A"